ELECTRIC WIRING SIMULATION DEVICE AND RECORDING MEDIUM RECORDING SIMULATION PROGRAM FOR ELECTRIC WIRING SIMULATION DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an electric wiring simulation device for simulating the characteristics of an electric wiring when the wiring is short-circuited. The present invention particularly relates to an electric wiring simulation device capable of making a simulation as to whether or not the protecting part of an electric wiring is fused and whether or not the wiring smokes and a recording medium recording a simulation program for the electric wiring simulation device.

2. Description of the Related Art

To simulate the circuit characteristics of a semiconductor integrated circuit, there is conventionally proposed a simulation method (Japanese Patent Application Laid-Open No. 8-327698) capable of more accurately obtaining current and voltage in view of the self-heating of circuit elements. This method does not, however, simulate the characteristics of an electric wiring such as a wire harness when the wiring is short-circuited.

To conduct a characteristics test while the electric wiring is short-circuited, therefore, a wire harness is actually formed as a sample and the sample wire harness is actually short-circuited.

The conventional wire harness characteristics test will be described based on Fig. 1. In the conventional wire harness characteristics test, a wire harness 101 serving as a test sample is connected to the positive terminal of a battery 102 serving as a power supply and a load terminal 103 which becomes a short-circuited region is connected to the negative terminal of the battery 102 through a knife switch 104.

Then, the knife switch 104 is turned on to short-circuit a circuit, a short-circuit current value at this time is obtained by a clamp ammeter 105 and measured by a memory HiCoder 106. Time taken for a protecting part 107 such as a fuse to be fused is also measured.

According to a conventional test, a wire harness serving as a sample is actually

formed, actually short-circuited and a test is conducted to judge whether or not the protecting part is normally operated and fused or whether or not the wire harness smokes.

However, a characteristics test conducted using the above-described sample wire harness cannot be conducted unless the sample wire harness is actually formed, so that a timely test cannot be disadvantageously conducted. Furthermore, if a test is conducted while the sample wire harness is short-circuited, not only the sample wire harness but also other parts such as a battery and respective switches are necessary, whereby cost for testing material is disadvantageously pushed up.

SUMMARY OF THE INVENTION

The present invention has been made under the above-described circumstances. It is, therefore, an object of the present invention to provide an electric wiring simulation device capable of making a simulation as to whether or not the protecting part of an electric wiring is fused and whether or not the wiring smokes and to provide a recording medium recording a simulation program for the electric wiring simulation device.

The first aspect of the invention provides an electric wiring simulation device simulating characteristics of an electric wiring while the electric wiring is short-circuited, comprising: a characteristics information data base for storing parts information on parts and wirings constituting a test object circuit, discharge characteristics of a power supply, current-prearcing time characteristics of protecting parts and current-smoke time characteristics of the wirings; an assigned path searching unit for searching an assigned path between a short-circuit point and the power supply when the short-circuit point on the test object circuit is assigned; a current value calculating unit for calculating a resistance value on the assigned path searched by the assigned path searching unit, and calculating a short-circuit current value based on the resistance value and the discharge characteristics of the power supply; and a judging unit for judging whether each protecting part on the test object circuit is fused and whether each wiring of the assigned path smokes based on the short-circuit current value calculated by the current value calculating unit, the current-smoke time characteristics and the current-prearcing time characteristics, at unit time intervals.

According to the first aspect of the invention, it is possible to make a simulation as to whether or not the protecting part of an electric wiring is fused and whether or not the electric wiring smokes.

The second aspect of the invention provides an electric wiring simulation device according to the first aspect of the invention, wherein the current value calculating unit takes account of the resistance value during heat emission based on a change in the resistance values with respect to time, the resistance values included in the parts information.

According to the second aspect of the invention, it is possible to make a simulation in view of changes in resistance values due to the heating of respective parts and respective wirings.

The third aspect of the invention provides a recording medium recording a simulation program for an electric wiring simulation device simulating characteristics of an electric wiring while the electric wiring is short-circuited, the recording medium comprising: a storage processing for storing parts information on parts and wirings constituting a test object circuit inputted as a simulation object, discharge characteristics of a power supply, current-prearcing time characteristics of protecting parts and current-smoking time characteristics of the wirings, in a data base; an assigned path searching processing for searching an assigned path between a short-circuit point and the power supply when the short-circuit point is assigned on the test object circuit; a current value calculating processing for calculating a resistance value on the assigned path searched in the assigned path searching processing, and for calculating a short-circuit current value based on the resistance value and the discharge characteristics of the power supply; and a judging processing for judging whether each protecting part on the assigned path is fused and whether each wiring on the assigned path smokes based on the short-circuit current value calculated in the current value calculating processing, the current-smoke time characteristics and the current-prearcing time characteristics, at unit time intervals.

According to the third aspect of the invention, it is possible to make a simulation as to whether or not the protecting part of an electric wiring is fused and whether or not the electric wiring smokes.

The fourth aspect of the invention provides a recording medium recording a

simulation program for an electric wiring simulation device simulating characteristics of an electric wiring according to the third aspect of the invention, wherein the current value calculating processing is conducted while taking account of the resistance value during heat emission based on a change in the resistance values with respect to time, the resistance values included in the parts information.

According to the fourth aspect of the invention, it is possible to make a simulation in view of changes in resistance values due to the heating of respective parts and respective wirings.

The fifth aspect of the invention provides A simulation program for an electric wiring simulation device simulating characteristics of an electric wiring while the electric wiring is short-circuited, the simulation program comprising: a storage code segment for storing parts information on parts and wirings constituting a test object circuit inputted as a simulation object, discharge characteristics of a power supply, current-prearcing time characteristics of protecting parts and current-smoking time characteristics of the wirings, in a data base; an assigned path searching code segment for searching an assigned path between a short-circuit point and the power supply when the short-circuit point is assigned on the test object circuit; a current value calculating code segment for calculating a resistance value on the assigned path searched in the assigned path searching code segment, and for calculating a short-circuit current value based on the resistance value and the discharge characteristics of the power supply; and a judging code segment for judging whether each protecting part on the assigned path is fused and whether each wiring on the assigned path smokes based on the short-circuit current value calculated in the current value calculating code segment, the current-smoke time characteristics and the current-prearcing time characteristics, at unit time intervals.

According to the fifth aspect of the invention, it is possible to make a simulation as to whether or not the protecting part of an electric wiring is fused and whether or not the electric wiring smokes.

The sixth aspect of the invention provides a simulation program for an electric wiring simulation device simulating characteristics of an electric wiring while the electric wiring is short-circuited according to the fifth aspect of the invention, wherein the current value calculating code segment is conducted while taking account of the

resistance value during heat emission based on a change in the resistance values with respect to time, the resistance values included in the parts information.

According to the sixth aspect of the invention, it is possible to make a simulation in view of changes in resistance values due to the heating of respective parts and respective wirings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an explanatory view for a conventional wire harness short-circuit test;

Fig. 2 is a block diagram showing the constitution of one embodiment of an electric wiring simulation device according to the present invention;

Fig. 3 is a flow chart for describing simulation processings for the electric wiring simulation device 1 shown in Fig. 2;

Fig. 4 shows one example of an input screen for the electric wiring simulation device 1 shown in Fig. 2;

Fig. 5 shows one example of a part select screen for the electric wiring simulation device 1 shown in Fig. 2;

Fig. 6 shows one example of a parts information input screen for the electric wiring simulation device 1 shown in Fig. 2;

Fig. 7 shows one example of a wire data input screen for the electric wiring simulation device 1 shown in Fig. 2;

Fig. 8 shows one example of an input screen displaying a test object circuit for the electric wiring simulation device 1 shown in Fig. 2;

Fig. 9 is an explanatory view for the assignment of a plurality of short-circuit points for the electric wiring simulation device 1 shown in Fig. 2;

Fig. 10 shows one example of a screen displaying assigned path searching results for the electric wiring simulation device 1 shown in Fig. 2;

Fig. 11 shows one example of parts information stored in a characteristics information data base 4 shown in Fig. 2;

Fig. 12 shows one example of current-prearcing time characteristics and current-smoke time characteristics stored in the characteristics information data base 4 shown in Fig. 2;

Fig. 13 shows one example of a simulation result display screen if the

protecting circuit is fused, for a simulation made by the electric wiring simulation device 1 shown in Fig. 2;

Fig. 14 shows one example of a simulation result display screen if the wiring is burned, for a simulation made by the electric wiring simulation device 1 shown in Fig. 2;

Fig. 15 shows one example of a simulation result display screen if no trouble occurs, for a simulation made by the electric wiring simulation device 1 shown in Fig. 2; and

Fig. 16 shows the results of a simulation conducted to a plurality of short-circuit points of the test object circuit.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, the embodiments of an electric wiring simulation device and a recording medium recording a simulation program for the electric wiring simulation device according to the present invention will be described with reference to the drawings.

As shown in Fig. 2, the electric wiring simulation device 1 in this embodiment comprising an input device 2 inputting instructions from an operator responsible for an electric wiring simulation, a processing device 3 executing electric wiring simulation processings, a characteristics information data base 4 storing information on respective parts and wirings necessary for the simulation processings, and a display 5 outputting simulation input screens and simulation results.

The processing device 3 includes an assigned path searching unit 11 searching an assigned path between a short-circuit point on a test object circuit inputted as a simulation object and a power supply when the operator assigns this short-circuit point, a current value calculating unit 12 calculating a resistance value on the searched assigned path, and calculating a short-circuit current value based on this resistance value and the discharge characteristics of the power supply, and a judging unit 13 judging whether or not each protecting part on the assigned path is fused and each wiring on the assigned path smokes based on this short-circuit resistance value, current-smoke time characteristics and current-prearcing time characteristics at unit time intervals. The processing device 3 is constituted by an ordinary computer system including a CPU for

conducting various processings and a storage unit storing instructions for the respective processings. The instructions and timing restrictions for the respective processings conducted by the processing device 3 are held by the storage unit and loaded to and executed by the CPU as required.

The characteristics information data base 4 stores parts information on parts and wirings constituting the test object circuit, the discharge characteristics of the power supply such as a buttery, the current-prearcing time characteristics of the protecting parts such as a fuse and a fusible link and the current-smoke time characteristics of the respective wirings.

A simulation processing conducted by the electric wiring simulation device will be described based on the flow chart of Fig. 3.

When a simulation processing starts, an input screen showing an operation menu is displayed on the display 5 as shown in Fig. 4 (in a step S201). The operation menu includes File (F), Part (P), circuit Bifurcation (B) and circuit Confluence (C), Wire (W), ET Cetera (ETC), Edition (E), Comprehensive Edition (CE), Function (FC), Image Processing (IP), Master Maintenance (MM), Reduced-size Display (RD) and Characteristics Display (CD).

An operator chooses parts used in a test object circuit and inputs the disposition of the parts so as to form the test object circuit serving as a simulation object (in a step S202). To choose parts, P1, P2, P3 and the like are clicked on the operation menu on the input screen and parts are chosen from a select window shown in Fig. 5. The positions at which the parts are disposed are inputted by clicking on the positions on the input screen.

If the parts and the disposed positions thereof are determined as described above, a select window for the part name and type of each part is displayed as shown in Fig. 6 and the part name and type thereof are inputted (in a step S203).

Wirings are formed by clicking on 'W' on the operation menu on the input screen and the parts are connected by the wirings (in a step S204). Battery-side parts are clicked on from among the parts to be connected and then earth-side parts are clicked on. Then, the length, size, wire harness name and circuit code of each wire are inputted on a wire data input window shown in Fig. 7.

The above-described processing is repeatedly carried out until the test object

circuit is formed (in a step S205) and the test object circuit shown in Fig. 8 is formed. Relays and switches on the test object circuit are changed to thereby set the circuit for making a simulation (in a step S206).

If the formation and setting of the test object circuit are completed as described above, a simulation for a short-circuited test object circuit is started.

A short-circuit part is assigned by clicking on the part to be short-circuited on the test object circuit displayed on the screen (in a step S207). At this time, the operator may input a plurality of short-circuit points in advance to allow the next short-circuit point to be automatically simulated instead of assigning only one short-circuit point. For example, in case of the test object circuit shown in Fig. 9, the operator inputs short-circuit points numbered ①, ②, ③, ..., automatically assigns the short-circuit points in this order and makes a simulation.

When the short-circuit points are assigned as described above, a path between each short-circuit point and the power supply such as a battery is searched. As shown in Fig. 10, the assigned path is assumed as a assigned path 91, displayed on the screen by discriminating the path 91 from the other paths and a short-circuit point 92 is indicated by an arrow (in a step S208).

The initial resistance values of the parts and wirings on the assigned path are read by searching the parts information stored in the characteristics information data base 4 and the initial resistance value of the assigned path is calculated by obtaining the sum of these initial values (in a step S209). The parts information is information including the type, name, current capacity, initial resistance value and the like of each part. By way of example, Fig. 11 shows parts information on the fusible links.

Furthermore, the initial resistance value of the assigned path and the initial short-circuit current value of this assigned path are calculated based on the discharge characteristics of the buttery stored in the characteristics information data base 4 (in a step S210). Here, the discharge characteristics of the buttery represents the voltage V of the buttery after time t (sec). The voltage after short circuit time 0 (sec) is read from this discharge characteristics, so that the initial short-circuit current value is calculated from the voltage thus read and the initial resistance value.

The initial resistance value and the initial short-circuit current value thus calculated are displayed on the window 93 shown in Fig. 10. If the corrections of the

initial values are necessary, corrected values are inputted on this window 93 to thereby correct the initial values (in a step S211). The initial value corrections are made to conform the values to data in a case where the electric wirings such as wire harnesses are actually mounted on a vehicle. For example, if it is known in advance that the short-circuit current value in the simulation data is lower than a short-circuit current value in a case where the electric wirings are actually mounted on the vehicle, the short-circuit current value in the simulation data is corrected in advance in view of the difference. Likewise, the initial resistance value is corrected.

When the corrections are completed and "No Correction" button is pressed on the window 93 shown in Fig. 10, simulation conditions are set (in a step S212). The conditions to be set include predetermined unit time for repeating the simulation and progress time for executing the simulation. Description will be given herein while assuming that the unit time is set at 0.1 (sec) and the progress time is set at 1800 (sec).

First, it is judged whether or not the protecting parts of the test object circuit are fused in first 0.1 (sec) (in a step S213). Next, it is judged whether or not the wirings of the test object circuit are burned (in a step S214). Here, the judgments as to whether or not the protecting parts are fused and whether or not the wirings are burned are made based on the current-prearcing time characteristics and current-smoke time characteristics stored in the characteristics information data base 4. Fig. 12 shows one example of the current-prearcing time characteristics and the current-smoke time characteristics. The judgment as to whether or not each protecting part is fused and each wiring is burned will be described based on Fig. 12. In Fig. 12, the horizontal axis indicates short-circuit current value and the vertical axis indicates time. A curve S1 indicated by a solid line shows the current-prearcing time characteristics of the protecting part rated 40A, that is, the current-prearcing time is time for the protecting part to be fused with respect to the short-circuit current value. A curve S2 indicated by a dotted line shows the current-smoke time characteristics of the 124-sq wiring, that is, the current-smoke time is time for the wiring to smoke (or to be burned) with respect to the short-circuit current value.

In Fig. 12, for example, after 1 (sec) from the start of the simulation, if the short-circuit current value exceeds about 142 (A) as indicated by a point P1, the protecting part is fused and if the short-circuit current value is lower than 142 (A), the

protecting part is not fused. After a point P2 at which about 15 (sec) is passed from the start of the simulation, the current value with which the wiring smokes is lower than the current value with which the protecting part is fused. As indicated by, for example, a point P3, if the short-circuit current value exceeds 50 (A) after 40 (sec) from the start of the simulation, the wiring is burned.

Based on the current-prearcing time characteristics and current-smoke time characteristics, whether or not the protecting part is fused and whether or not the wiring is burned are judged. If the protecting part is fused, the results of the simulation are displayed on the display 5 as shown in Fig. 13, and if the wiring is burned, the results of the simulation are displayed on the display 5 as shown in Fig. 14 (in a step S215). The results of simulation include a fused or burned position, time for the protecting part to be fused or time for the wiring to be burned, a current value at that time and the like.

Furthermore, if the protecting part is not fused and the wiring is not burned in the unit time during which the judgments are being made, then it is judged whether or not the progress time satisfies the set time 1800 (sec) (in a step S216).

If the progress time does not satisfy the set time, the short-circuit current value in the next unit time is calculated (in a step S217) and the processing after the step S213 is repeated. The short-circuit current value in the next unit time is obtained as follows. A discharge voltage after t (sec) is read from the discharge characteristics of the power supply stored in the characteristics information data base 4. Furthermore, the resistance values of the respective parts and respective wirings after t (sec) are read from the part information. The short-circuit current value is calculated based on the voltage value and the resistance values. The resistance values after t (sec) are calculated in light of a change in respective part and wirings due to the heat emission of the parts and wirings, and the resistance values are stored in the characteristics information data base 4 as parts information.

As described above, the short-circuit current value is calculated in view of a change in resistance values if the respective parts and wirings are heated, whereby a simulation in view of a change in resistance values due to the heat emission of the wirings and parts can be made. If the progress time satisfies the set time in the step S216, the results of the simulations are displayed on the display 5 as shown in Fig. 15 (in the step S215) and the simulation is completed.

Furthermore, the similar simulation can be automatically repeated while changing short-circuit points on one test object circuit and the results of these simulations can be collectively outputted in the form of a report as shown in Fig. 16.

According to the electric wiring simulation device 1 in this embodiment, it is possible to make a simulation as to whether or not the protecting parts of the electric wirings are fused and the wirings smoke without the need to actually form a prototype and to conduct a short-circuit test.

It is noted that a program for realizing the respective processing steps of the above-described electric wiring simulation device can be stored in a storage medium. By allowing the computer system to read this storage medium, the program can be executed and the respective processing steps of the above-described electric wiring simulation device can be realized while controlling the computer. The recording medium is exemplified by a device, such as a memory device, a magnetic disk device or an optical disk device, capable of recording the program.